Superheaters on Locomotives

It MAY be said that, with possibly the exception of the Glasgow and South-Western Railway, there is not a single important railway in the British Isles that is not now using superheaters for locomotive work, a truly remarkable instance of the rapid adoption by locomotive engineers of progressive ideas, seeing that only a few years ago the superheater was practically unknown on the railway.

British engineers, however, are not alone in thus speedily recognizing a good thing. Of that fact there was ample evidence at the recent Paris meeting of the Institution of Mechanical Engineers, particularly in the paper by Professor Edouard Sauvage on "Recent Development of Express Locomotives in France." According to the professor, with the exception of some Atlantic type locomotives—which are not likely to be reproduced, by the way—all engines built for express work in France during the past decade are six-coupled, being either ten-wheelers (4-6) or Pacifics (4-6-2). On these superheated steam is largely used, with a few exceptions, the Schmidt standard superheater being the type generally adopted.

With regard to this increasing use of superheaters, Professor Sauvage makes the interesting comment that owing to the large tubes necessary to receive the superheating pipes, it frequently happens when a superheater is fitted to a locomotive boiler that the proper heating or vaporizing surface is greatly curtailed; in fact, in many engines the total of the heating and superheating surface is less than the heating surface that night have been obtained without superheating.

Without superheaters the heating surface equals 72 to 77 times the grate area in engines having narrow fire-boxes, and 60 to 62 times in the case of wide fire-boxes. With superheaters the ratio of proper heating surface to grate area is as low as 50, and does not exceed 60. Although the results in service are good in all cases of superheating, this large reduction of heating service can hardly be regarded as entirely satisfactory.

No difficulty is reported to arise from the use of superheaters. They are found to be easily kept in order, and valves and pistons, when properly lubricated with an efficient oil, do not give signs of undue wear even with a high superheat—up to 340 deg. C.

Except in the case of one French company, all engines for express service have four cylinders, with a large proportion of compounds. In a few cases simple expansion, in four equal cylinders, is used, but the compound system appears altogether to be preferred. The one exception is the recent building of the Midi Railway for express purposes, of simple engines with only two cylinders and using superheated steam. Of course, simple engines on this principle exist on other railways, but they are not used for fast service.

When superheaters have been added to the four-cylinder compounds, the diameter of the high-pressure cylinders has been increased, the low-pressure cylinders being left unaltered. Piston valves are generally used on all cylinders, even on non-superheaters, but in a few cases, for instance, on Paris-Orleans engines, flat valves have been preserved on the low pressure cylinders of superheaters.

Other systems of superheaters besides the Schmidt have been experimented upon. At first, for fear of overheating the high-pressure cylinders, superheating in two stages was resorted to; high-pressure steam being moderately heated, receiver steam being passed to a second superheater. This plan, Professor Sauvage records, has been abandoned. A helical superheater, on the principle of the field tube, with ribs, was fitted to some engines, and was abandoned on account of its insufficient surface and of the difficulty of cleaning its outside ribs. Another system tried is known as the Mestre "squirrel-cage" superheater; this is working on some engines, and gives ample surface.

On the French railway—the Nord line—the engineers speak most favorably of their superheaters, and they agree that to get the best results superheating must be combined with compounding, a system which is to be adopted in future locomotives. It is found that with steam temperatures of 300 deg. to 340 deg. C., no undue expenses for repairs have had to be met. As regards actual working experience, we have the testimony of the chief engineer of the Nord Railway, M. Asselin, who advised Professor Sauvage that "until 1904 our fast engine was an Atlantic without superheater, a four-cylinder compound with a horse-power of 1,400 (1,380 b.h.p.). The first step was to increase the power of these Atlantics by the addition of a superheater. Although taking heavier trains, these engines with superheaters showed an economy of at least 5.3 lb. of coal per mile. The second step was to build Pacifics of about 1,900 h.p. (1,873 b.h.p.). It is remarkable how economical these engines proved. With the same weights they consume practically the same quantity of coal as the Atlantics with superheaters; and with the heavier loads than the latter could manage without superheaters the Pacifics burn less coal."

Other valuable comparative data were collected by the chief engineer of the Paris-Orleans railway, who made an interesting comparison in actual running of twenty Pacifics without and of fifteen with superheaters. The mean coal consumption per 100 ton-mile was in winter (including steam for heating the trains) 13.8 lb. for engines without superheaters, and 12.4 lb. in the case of engines with superheaters. A saving of no less than 10 per cent. is thus shown to exist in favor of the superheat. Thanks to superheating, it can be placed on record that in a period of fourteen years, during which the weight of trains on the Nord Railway has been doubled, the coal consumption has remained practically stationary, and it is much the same story on many other lines.

But, as has been pointed out by those eminent English locomotive engineers, Messrs. J. A. F. Aspinwall and G. Hughes, the coal bill is only one item of expense in locomotive working, although the rise in the price of coal makes it more and more important; the economy of first cost in the case of two-cylinder simple engines must be taken into account.—*The Daily Telegraph.*

Explosive Mixtures of Gases*

An explosion is essentially a very rapid combustion which occurs almost simultaneously in all parts of a mass of combustible substance. The heat developed by the combustion raises the gaseous products of combustion to a very high temperature, and gives them the enormous pressure and expansive tendency which produce the destructive effects of explosives.

In order that combustion shall be almost instantly propagated throughout a mass of gas it is necessary that the air required for combustion shall be intimately mixed with the combustible gas, and in order to attain the high temperature requisite for explosion the mixture must not contain a large quantity of gas that takes no part in the combustion, for such a mass of inert gas would exert a cooling effect. This consideration leads to the law, which is confirmed by experience, that mixtures of combustible gas with air are explosive only when the percentage of combustible gas in the mixture lies between certain limits. These limits, for some important gases and vapors, are given in the following table:

Gas or Vapor.	Percentage of Gas in Explosive Mixture.	
	Upper Limit.	Lower Limit.
Hydrogen	66.4	9.45
Illuminating gas	19.1	7.9
Methane (marsh gas)	12.8	6.1
Alcohol vapor	13.65	3.95
Ether vapor	7.7	2.75
Benzin vapor	4.9	2.4

The explosive limits, however, are dependent to some extent upon the size and shape of the containing vessel and upon the character of the ignition (strong electric spark, weak spark, or flame).

It will be observed that the proportion of combustible gas required to form an explosive mixture with air is very small, except in the case of hydrogen. Explosion may be caused by the presence of less than 3 per cent of ether or benzine vapor in the atmosphere. In general, however, the danger of explosion is proportional to the range of explosiveness, i. e., the difference between the upper and lower explosive limits, and is consequently greatest in the case of hydrogen.

The danger of explosion can obviously be averted by preventing the mingling of the combustible gas with air. The idea, still widely prevalent, that certain gases are explosive in themselves, is erroneous, as was proved in a very striking manner by Samuel Clegg at the installation of the first gas-house in London. To the consternation of the examining commission Clegg bored a hole in the wall of the gas-holder and ignited the issuing stream of gas. A long flame shot out, burned quietly, without the slightest explosion, until it was extinguished by the sinking of the gas-holder bringing the hole below the level of the surrounding water. When an attempt was made to blow up a Glasgow gas house with dynamite only the iron parts were shattered, and the escaping gas burned without explosion. In such cases the ignition of the escaping gas is a safeguard against explosion as it prevents the formation, in large quantities, of explosive mixtures of gas and air.

Even an explosive mixture can be prevented from exploding by the addition of an inert gas. This is of great practical importance because such an inert gas is available in large quantities in the carbon dioxide which constitutes from 8 to 14 per cent of the chimney gas of steam boiler furnaces. Eitner and Trautwein have proved that any mixture of illuminating gas and air can be made inexplosive by the addition of 7½ per cent of carbon dioxide. This fact is utilized for the prevention of explosion due to the mingling of gas and air in the first filling of new gas holders and gas pipes. Furnace gas is blown through the system before the illuminating gas is admitted.

In even the most explosive mixtures explosion can be prevented by cooling below the temperature of ignition. A jet of such a mixture, issuing from a tube a diameter less than 1/12 inch, may be ignited without exploding the mixture inside the container, because of the cooling effect of the walls of the small tube. The construction of Davy's safety lamp for miners is based on this principle. The flame is inclosed in fine wire netting, which is equivalent to a multitude of small tubes. Fire damp (methane), if present in the air of the mine, enters the net and burns therein, without exploding the mixture of gas and air outside.

Some explosive mixtures of gases are usefully employed in heating by gas, in incandescent gas lighting, and in explosion motors. All gas heaters and incandescent burners operate on the principle of the Bunsen burner, which automatically mixes the illuminating or fuel gas, before combustion, with a quantity of air. In gas stoves this addition of air is made in order to produce a non-luminous flame, to prevent the blackening of objects exposed to the flame, and to assure complete and odorless combustion of the gas. These objects are the more perfectly attained the larger the proportion of air that is added to the gas. When illuminating gas at the usual pressure, however, is mixed with more than thrice its volume of air (a quantity insufficient for complete combustion) the velocity of efflux is less than the velocity of propagation of ignition, so that the flame "strikes back." The quantity of air added can be increased by increasing the pressure of the gas. This is especially advantageous in incandescent gas lighting where it is desirable to concentrate the combustion in a small space in order to produce a high temperature, and, consequently, an intense luminosity.

In explosion motors it is advantageous to use as little gas as possible, i. e., to approximate as closely as possible to the lower explosive limit. Richer mixtures (corresponding to the upper limit) cause violent explosions, which are far less completely utilized by the moving parts than the mild explosions and expansion produced by mixtures poor in gas. With some mixtures, especially hydrogen and air, these violent explosions may destroy the motor. The operation of explosion motors with very small quantities of gas or vapor is facilitated by the fact that the explosive range is considerably extended at the high temperatures and pressures that prevail in the interior of the cylinder. These principles have been utilized so fully in recent years that the motors of automobiles have attained a perfection that no one would have ventured to predict twenty years ago. This remarkable development is due to increased knowledge of the behavior of explosive mixtures of gas, and this knowledge has been acquired from practice, not from purely scientific researches. In this field practice is far ahead of pure science.

Notes on the Geology of Texas*

In the northwest part of the State, east of the Pecos, the formations lie nearly horizontal. This structure prevails over the entire Plains, extending from the north end of the Panhandle to a line joining San Angelo and Pecos on the south. This area measures 330 miles from north to south and 170 miles from east to west. The deeper lying rocks can hence be known here only from inferences based on their appearance in distant outcrops outside of this area and from such local observations as may be obtained from deep explorations. It is singularly fortunate for our knowledge of the stratigraphy of this part of the continent that a deep boring was made at a point not far from the central part of the area defined. The exploration enables us to know by actual observation what strata underlie. It furnishes a first-hand information of the stratigraphy of this part of the State.

The deepest boring in Texas is now at Spur, in Dickens County, and was made in search of water for the town of Spur, and as a general exploration of the formations of the vicinity. The hole was abandoned and wrecked in November, 1913, at the depth of 4,489 feet. The remarkable feature of the boring was the continuity and the persistency of the rock. The log shows what a tremendous bed of rock was penetrated.

The strata explored by this boring constitute three well marked divisions. The upper 1,250 feet consist of red sands, clays, marls, beds of gypsum, anhydrite, and salt, all in different gradations of purity and intermixture. This is the Permian Red Beds, constituting a part of the Double Mountain formation. The succeeding 2,850 feet consist of dolomite, with strata of anhydrite, sandstone, and shale. These are probably to be correlated with the Delaware formation west of the Pecos and are, no doubt, the equivalent of the Wichita and the Albany, the Clear Fork, and part of the Double Mountain formation. The lowest 389 feet of the section explored consist of limestone and shale, which are believed to correspond to the upper part of the Cisco formation of central Texas.

* From the *Bulletin* of the University of Texas. "The Deep Boring at Spur," by J. A. Udden, geologist for the Bureau of Economic Geology and Technology.

* Translated from Victor Rodt's article in *Die Umschau.*

The uppermost 300 feet of the Red Beds consist of fine silt and clay impregnated with iron oxide, which gives it mostly a deep red color. From 400 to 900 feet below the surface the Red Beds consist for the most part of fine red sand or standstone. The lower 350 feet of the Red Beds consist of a sandy silt mixed with varying amounts of salt, in which the sand and silt particles are imbedded as in a matrix.

There were three beds of pure salt; one ten feet thick, from 570 to 580 feet below the surface; another five feet thick, from 633 to 638 feet; and a third nine feet thick, from 732 to 741 feet. The upper bed consists of white granular salt showing thin red seams about a half millimeter apart, due to the presence of red silt. The lowermost bed is clear, crystalline sale which is transparent, except for imbedded blotches of silt which shows no well-marked stratification.

At Spur, as elsewhere, the most characteristic persistent ingredient in the sediments of the Red Beds consists of calcium sulphate minerals, gypsum, and anhydrite.

From 1,250 feet below the surface down to 4,095 feet the drill was going through what is essentially a formation of dolomites, interrupted by beds of sandstone, shale, and anhydrite, the last of which is to some extent of secondary origin. The thickness of this series is 2,845 feet.

The main accessory sediments in the dolomitic beds are sand, shale, and anhydrite.

In many of the thin sections of dolomite, black, brownish, or yellowish streaks were noted, that evidently were not iron or manganese oxide. On heating parts of some of these samples, and several others, in a closed tube, it was found that nearly all such rock yielded fumes of bituminous materials. In several cases, perceptible films or even minute drops of oil were obtained.

Fragments of limestone first began to appear with the cuttings from 4,100 to 4,105 feet. After its first appearance, the limestone increased in quantity steadily in the returns from the next forty feet. Below 4,150 feet the samples contained but little dolomite, consisting mostly of limestone and shale, down to the bottom of the well.

It is believed that the strata penetrated by the lowermost 394 feet of this boring are to be correlated with the upper part of the Cisco formation in the central part of the State. They consist of limestone and shale. Limestone is the chief rock from 4,100 to 4,400 feet, while the lowermost 89 feet are mostly shale.

Only a few macroscopic fossils were seen. These were in a core taken between the depths of 2,244 to 2,264 feet. All other fossils were minute forms, found either in thin sections of dolomite and limestone or recovered by washing the triturated material in samples of cuttings taken by the drillers.

The principal fossil-bearing horizon is the Cisco, the lowermost 389 feet of the exploration. Fossils occur in the limestone as well as in the shale. Fusulina, Rhombopora, other bryozoa, and crinoid stems were noted most frequently in the limestone. Chitinous and other agglutinate foraminifera, jaws of annelids, and spicules of sponges were most frequent in the shales. A majority of these fossils are known from the Carboniferous in Europe and America, a few are known from the Permian, and some have probably not been reported from any other locality.

A few fossils were noted at scattered intervals in the samples coming from the shaly dolomite beds.

This boring emphasizes the fact, long known, that water is very scarce in the Pennsylvanian and the Permian sediments on the plains of the Southwest, and also that most of the water they contain is too salty for use. The chances are that, if any deep potable water will ever be found in the Red Bed area, it will come from below the Pennsylvanian, and perhaps below the entire Carboniferous, at some depth exceeding 5,000 feet. There can be little doubt that there are at least several hundred, and probably more than a thousand, feet more of Pennsylvanian strata under the bottom of this boring. The existence of such deep water is highly improbable.

What may eventually be the most important economic result of this boring is that it has proved the existence in the dolomite beds of a stratum, or horizon, from which comes a water sufficiently rich in potash to hold out inducement to prospective search for this mineral.

Considering the great value of a workable deposit of potash, it seems worth the while to call attention to another circumstance in connection with these observations. In either direction north or south from Spur the formations lie practically horizontal for at least a hundred miles, and the potash-bearing horizon, whether it be such or not in other places, must be at about the same depth as here, in these directions. It seems to the writer that the general conditions indicated in this boring, the existence of great salt beds and beds of anhydrite, together with the proven potash-bearing

stratum, warrants an examination for potash in water from the same horizon in any boring made in this territory.

The rocks of the dolomitic beds, and still more the rocks of the Cisco, must be regarded as sufficiently bituminous to produce large accumulations of oil and gas under favorable structural and lithological conditions. But the fact that the entire column of formations explored in the well below the Red Beds consists of compact sediments that not even yield salt water, shows that the rocks are not in this locality sufficiently porous to have permitted the accumulation of any fluids they may have contained. Everything considered, the prospect for oil or gas in this vicinity must be regarded as decidedly discouraging.

The Work of a Naval Wireless Operator in Times of War*

WAR! Martial law has been proclaimed, the fleets have been mobilized, and the battle maneuvers are now being "practised" in deadly earnest. It is one thing to repel a friendly enemy; it is quite another when the opposing naval forces are, next to our own, the finest in the world.

Let us suppose we are reconnoitering in hostile waters. The cruisers are ordered to spread themselves out in the vanguard of the fleet on lookout duty; they steam along without lights of any description. These great vessels, invisible as the night can make them, are brooding on the troubled waters. Yet they are very alive. Ceaselessly they communicate one with another, for in each vessel, hidden as far as possible from external view, is the soundless and padded wireless room. Here the operator is at work, the electric lamp glowing brilliantly above him; but a messenger enters with an order from the commander; immediately, as the handle of the door is touched and pulled open by the entrant, the lights go out, and pitch darkness prevails, until once again the door is closed behind him, and automatically the lights are switched on—that is part of the secrecy which prevails on a battleship in time of war. The men on lookout duties are stationed in various parts throughout the cruiser; their duty is to keep their eyes open, as there is always a chance that one of the enemy's destroyers may come rushing along at a speed of some 30 knots an hour, shoot a torpedo into the ship, and get away unscathed. At the best of times it takes a cunning gunnery to strike a vessel going at this speed; but in the darkness possibilities of the marauder's escape are increased tenfold, and only the eyes of the crew and watchers can, as far as possible, safeguard mishap. As soon as anything is sighted, it is reported to the battle fleet. This is done by the wireless, and the operator is compelled to work at high pressure, for he has to read every message a cruiser sends, inform his captain, and himself get in touch with the fleet if his officer should desire to send a reply. Then there is the admiral of a fleet to be considered. The operator must keep a good lookout in case some battle order should be transmitted from this important quarter.

All this time, remember, the ship is cruising at imminent risk, not only from the actual attacks of a secret enemy, but from the danger of floating mines and even aerial attack. It requires no little personal courage, therefore, for the operator to remain in that closed wireless cabin, whence, should disaster occur, there is no chance of escape, and all the time he must keep his head, and send and receive messages with as much nonchalance as though he were seated at home in the security of his own little den. But quiet heroism is one of the traditions of wireless service.

Very few people realize the great importance of wireless telegraphy, especially in time of war or strained relations. We will take, for instance, a fleet of battleships at sea while their country is at war with another power. Each ship in that fleet has its wireless installation, adjusted so that they can send and receive signals and messages to other squadrons at sea or in harbor and to stations ashore. One ship of that fleet is always in direct touch with the Admiralty. The chance of interference from an enemy's ship is reduced so as to be almost not worth counting. Each ship in a battle fleet is responsible for some station ashore, or for a cruiser squadron or flotilla of torpedo-boat destroyers.

The importance of having one ship in a fleet always looking out for messages from the Admiralty can be easily seen. All foreign intelligence and the movements of foreign ships go to the capital by telegraph, cablegram, and wireless from different parts of the world, and from thence it is transmitted to the admiral in charge of the fleet, who directs his ships accordingly. The whole safety of a battle fleet depends on wireless telegraphy in time of war. When a number of battleships are steaming along, perhaps looking for the enemy, it would not do for them to run into a superior number of the enemy's battleships.

* From the *Wireless World* for September.

To guard against this, a great number of cruisers are sent out ahead, and spread a number of miles across. The duty of these ships is to keep a thorough lookout and report to the ship in the battle fleet looking out on their particular tune. This ship, in turn, reports by semaphore or morse-lamp to the admiral of the battle fleet. The cruisers are sometimes assisted by torpedo-boat destroyers. Now, if 30 of these ships are used, it will be readily seen that the area of their vision is enormous, and it would be almost impossible for a fleet to pass unobserved. Immediately any of the ships sight the enemy's squadron, they would report at once by wireless, stating the number of ships sighted, with their speed, latitude, and longitude, etc. The admiral would then give his orders, also by wireless. If the admiral determines to attack, he directs the cruisers to steam at full speed, and take refuge behind the battle fleet.

Making a Comparison Spectrum

IT is often necessary when making a study of spectra, either terrestrial or celestial, to have a comparison spectra which is capable of furnishing certain of the standard lines. In the *Annual* of the Observatory of Good Hope, J. Lunt suggests that a convenient source for this has been found in the graphite of an ordinary lead pencil, which generally contains sufficient impurities to give lines of iron, titanium, vanadium, chromium, barium, strontium, calcium, and often gallium, scandium, yttrium, silicon, magnesium, manganese, in addition to the carbon.

WE wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject matter involved, or of the specialized, technical, or scientific knowledge required therefor.

We also have associates throughout the world, who assist in the prosecution of patent and trade-mark applications filed in all countries foreign to the United States.

<div align="right">

MUNN & Co.,
Patent Solicitors,
361 Broadway,
New York, N. Y.

</div>

Branch Office:
625 F Street, N. W.,
Washington, D. C.

Table of Contents